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The effects of international mobility on European researchers: comparing intra-EU and U.S. mobility

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THE EFFECTS OF INTERNATIONAL MOBILITY ON EUROPEAN RESEARCHERS: COMPARING INTRA-EU AND U.S. MOBILITY

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ABSTRACT

Using survey data on European-born and European-educated researchers who are internationally mobile after their PhD within Europe or to the United States, we find positive reported effects from international mobility on a range of facets, including scientific productivity, research environment and career development. Researchers mobile to the United States consistently report stronger positive effects than their peers who are mobile within the EU. This apparent 'U.S. premium', however, is almost entirely due to selection.

Keywords: international mobility; research productivity; career development; EU-US;

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1. INTRODUCTION

Ever more countries are introducing policies to selectively admit researcher migrants or to stimulate native researchers to be mobile (OECD, 2008). This policy interest is on the presumption that international mobility will stimulate research productivity and will create positive spillovers to the host and home country. The international mobility policy discussion at the EU level has tended to focus on stimulating intra-EU mobility, promoting the further integration of the European Research and Higher Education Area. A more sensitive issue is the outflow of talented European researchers to the United States, which is seen by some as positive, but by others as a "drain". In any case, U.S. mobility receives less (positive) EU policy attention and support compared to intra-EU mobility.

In this debate, it is important to have a better view on whether there are any differences in effects of mobility to the United States as compared to mobility within Europe. Although the effects of mobility are an essential element of our appraisal of researcher mobility, we know relatively little of the empirical magnitude of any differential effects of US vs intra-EU mobility.

In this paper, we provide evidence from a large scale survey on European researchers who have been mobile after their PhD either to other European countries or to the U.S. The survey data allow examining the effects of mobility for the two types of destination, along with the characteristics of the researcher and her environment shaping these effects. Although survey evidence is vulnerable to a subjectivity bias, it does allow to assess a broad range of effects from mobility, including, amongst others, improvement in working environment and impact on research career. We can thus examine not only whether but also on which dimensions the EU or the U.S. offer better 'returns to mobility'. And if there is any 'effect premium' for a particular destination, whether this is due to the mobility event, or due to a selection process on who is more likely to move where?

We find that the survey respondents report positive effects from international mobility on a range of facets, including scientific productivity, improvement of their working environment and career progress. European researchers mobile to the United States consistently report stronger positive effects than their peers who are mobile within the EU. This apparent 'U.S.

premium' is almost entirely due to selection. In particular, researchers mobile to the U.S. are more strongly career motivated than their intra-EU mobile peers. Once this selection is accounted for, there are hardly any differences in the effects reported by U.S.-mobile and EU-mobile researchers.

The remainder of the paper is organized as follows: section 2 reviews the relevant literature on the effects of mobility and discusses the possibility of a 'premium' for researchers mobile to the U.S. The third section describes the survey data. The fourth section presents the results, the fifth section concludes.

2. LITERATURE REVIEW ON THE EFFECTS OF INTERNATIONAL MOBILITY OF RESEARCHERS

International mobility can be seen as an investment in human capital: an individual moves to a country or region where her talents can be put to more productive use. This increased productivity generates additional income which offsets the costs of the move (Becker, 1962). This general framework can also be applied to researchers. There are several possible mechanisms that suggest how mobility can result in higher productivity or better career outcomes. Mobility, irrespective of whether it is international or not, can affect research productivity positively by improving the match between the researcher and her environment, through exposure to new ideas and methods, and by broadening the scope for synergies with other researchers (Edler et al ., 2011)

Mobility is also one of the prime mechanisms in the spreading of ideas (Goldin et al., 2011). For example, Azoulay et al. (2011) show that articles published before a scientist moves to a new location receive more citations from the destination after the move has occurred. The increased visibility of a researcher's work can broaden her professional network and enhance her general recognition in the field. This increase in citations illustrates at the same time the positive spillovers of mobility on the destination environment, as new ideas are introduced to the mobile researcher's colleagues (Azoulay et al., 2011). The effects of mobility extend beyond science into the realm of technology transfer, as mobile researchers tend to be more active in transferring technology to industry not only in the host country, but also in the host economy, at least for frequent travellers (Edler et al., 2011).

Most empirical analysis is on the effects of mobility on research productivity. This analysis mostly confirms that researchers are more productive in an environment that better fits their interests and abilities (Hoisl, 2007; Topel and Ward, 1992), while immobility has a negative impact on research productivity: researchers who remain employed at the institution where they obtained their PhD collaborate less with researchers outside their own university and produce less publications (Horta et al., 2010). Further evidence on the positive link between international mobility and scientific productivity is provided by the prevalence of the foreign born among top scientists. Stephan and Levin (2001) find that foreign-born researchers make exceptional contributions to U.S. science, more than expected given their share in the population of scientists. By contrast, Hunter et al. (2009), studying the migration patterns and scientific productivity of a sample of highly cited physicists, find that internationally mobile physicists do not have a higher h-index compared to non-mobile peers. They do however find that U.S.-located physicists, be they U.S.-born or foreign-born, have a significantly higher h-index, confirming the US as the top research environment for physics.

The exact destination and origin of the mobility move may matter for the effects, as it will shape the improvement in the match between the researcher and his environment. Kahn and MacGarvie (2008) study the publication productivity of foreign-born researchers with a U.S. PhD. They compare a group of PhD recipients who were funded by the Foreign Fulbright program, which requires students to leave the U.S. upon completion of the program, to a comparable group of control researchers who did not receive this type of funding. They find that researchers who return to poorer countries publish less and are cited less, whereas returnees from richer countries have similar publication and citation records as their peers who remain in the U.S.

When looking at top research environments as destination choices, the United States continues to provide the most prolific environment in many scientific disciplines. While the EU has been catching up with the U.S. in terms of quantity of publications, the United States nevertheless continues to outperform Europe when it comes to high-impact research in almost all scientific disciplines (e.g. Veugelers, 2010; Albarraan & Ruiz-Castrillo, 2012). With this top position of the U.S., does mobility to the United States yield more beneficial

effects for European researchers compared to mobility within Europe? Does it allow the U.S. to attract the best foreign brains?

There are indications that the United States attracts the best and brightest researchers, a phenomenon which has been coined the 'elite brain drain' (Hunter et al., 2009; Laudel, 2005). Among European students who move to the U.S. to obtain a PhD in economics, the best students are indeed more likely to stay in the U.S. to work at a top institution (Van Bouwel and Veugelers, 2013). Black and Stephan (2007) find that in several science and engineering fields, foreign PhD recipients who attended a top 10 PhD program in the U.S. are significantly more likely to indicate an intention to stay for the first job. Gaulé (2010) observes that the 20% most productive foreign chemistry faculty in the U.S. are significantly less likely to return later in their career. Kahn and MacGarvie (2008) also assume a selection effect among foreign PhD recipients in the U.S. who return, for which they try to correct by instrumenting return with funding and visa information. This touches on one of the biggest challenges in measuring effects of mobility: how to separate the effects of location and mobility from selection effects. If it is the case that the most talented and motivated researchers are more likely to become mobile to the best locations, then any positive effects we observe after mobility may be entirely due to this initial selection.

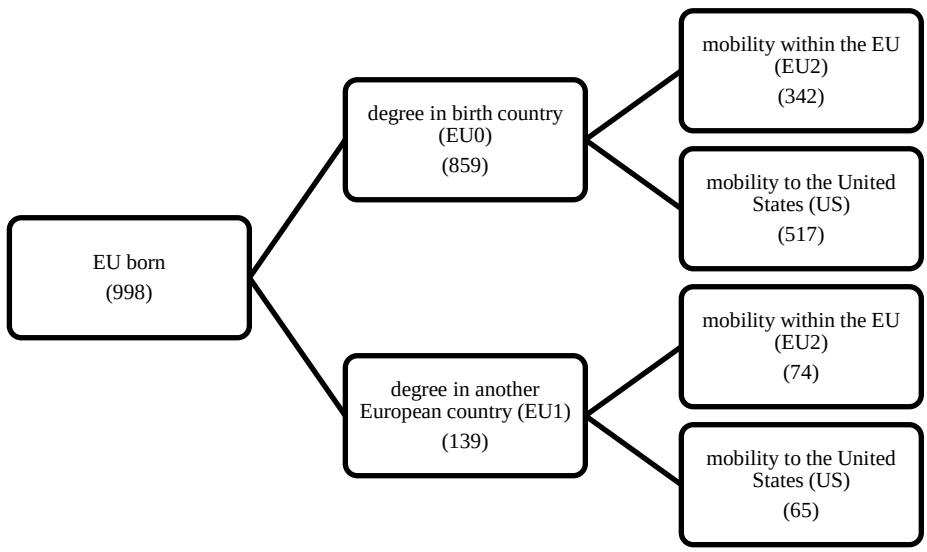
In this paper, we examine how mobility of European researchers within Europe and to the United States affects several aspects of researchers' careers. On the basis of the arguments presented above, we expect to observe positive effects of mobility on researchers' publishing productivity and general recognition. We assess whether this is linked to improvements in the researcher's research environment, such as access to infrastructure or a network of top peers in the field. We examine whether mobility to the United States is associated with more positive effects than mobility within Europe. We find that mobility to the United States is indeed associated with significantly more positive effects, but this difference is almost entirely due to selection: researchers who become mobile to the United States are, amongst other things, significantly more career motivated than their peers who remain mobile within the EU. Once this selection is controlled for, hardly any difference in effects of mobility to the United States and within Europe remains.

3. DATA

The analysis is based on data from the extra-EU MORE survey. Appendix 1 describes the MORE survey and the sample we have constructed from it. The sample of the MORE data we use contains EU-born researchers with *mobility experience*. We retain only those researchers who obtained their PhD in Europe, be it in their birth country (EU0) or in another European country (EU1), and who become mobile during their post-PhD career within Europe (EU0-EU2 or EU1-EU2) or to the United States (EU0-US or EU1-US)[2]. We exclude immobile researchers and those European researchers with a PhD degree from the United States. There are 998 researchers in this subsample, 582 of which are mobile to the United States and 416 who are mobile within Europe.

Figure 1 illustrates the breakdown of our sample into the various mobility groups. The number of respondents in each group and subgroup is included.

Figure 1: Mobility groups in the sample



The effects of mobility are addressed in the survey through an 8 item question asking respondents to indicate whether a particular item had strongly decreased, decreased, remained the same, increased or strongly increased, using a Likert scale from 1 to 5.

[2] A small number of researchers are mobile to other countries, such as Australia, but these are omitted from the analysis. Canada was originally considered together with the U.S. as one destination, North America, but after cleaning no European researchers mobile to Canada remained in the sample.

Respondents had the option of answering 'not applicable' if a particular item did not apply to them. The 8 items were the following:

Scientific output

1. Publication output
2. General recognition in the research community as a researcher

Research environment & research skills

3. Access to infrastructure and know-how
4. Access to an international network of professionals active in your field (or related fields)
5. Professional experience as a researcher

Career development

6. Future job opportunities in the country where you have previously worked/studied

Science-industry links

7. Patent output
8. Ability to work in the industrial sector

The first two effects, publication output and general recognition, are the main scientific output variables that hold our interest: do mobile researchers publish more, and does the impact of their work, in the form of general recognition by the research community, increase? The next three effects can be interpreted as indirectly enhancing a researcher's productivity by improving the researcher's working conditions: does the environment in which mobile researchers work improve, in terms of access to infrastructure and human resources? Does mobility enhance their professional experience as a researcher? The sixth item tries to assess whether mobility enhance researchers' future job prospects in the source country. Finally, effects 7 and 8 intend to capture enhanced industry science links. Not all effects are relevant to all researchers in all fields. Patents, for example, are more common in the exact sciences than in humanities[3]. All effects are positively correlated, clearly most strongly between items 1-2, 3-4-5 and 7-8.

[3] More than half of the respondents responded that effects on patent output and ability to work in industry were not applicable to them. A little over a hundred researchers also did not indicate an effect on their access to infrastructure.

The mobility effects measured in the survey are perceived effects. As the data are anonymous, we cannot match with publication information to assess the *actual* increase in publications. We can only compare whether researchers *perceive* different effects. An advantage of using self-reported, subjective effects is that it allows examining the effects of mobility on concepts that are hard to quantify with objective data, such as 'future career opportunities'. However, reported effects may be prone to biases such as a central tendency bias, i.e. avoiding extreme response categories, or a social desirability bias, i.e. respondents portraying themselves in a more favorable light. Asking mobile researchers about the effects of mobility will likely result in a bias towards positive responses. Moreover, survey respondents may have a tendency to provide high responses on rating scales (Sauermann and Roach, 2012), which could also lead to an overestimation of effects. As we cannot correct for these biases, the descriptive statistics must be interpreted with care and should mainly be used to compare across different effects. In the econometric analysis, however, we focus on the differences in responses between groups of mobile researchers. We assume that possible biases do not vary among mobile researchers and between the mobility groups. If it should be the case that U.S.-mobile researchers tend to give more optimistic responses than EU-mobile researchers, then the matching technique we employ might not eliminate this difference in response bias. However, it is reassuring that our findings indicate that no significant differences in effects are left after matching, which lends support to the assumption that any biases in responses do not vary over mobility groups.

4. RESULTS

Our main research question is how mobility of European researchers within Europe and to the United States affects several aspects of researchers' careers. When assessing effects from mobility, we examine any differences between mobility to the United States versus intra-EU mobility. In doing so, we will control for the selection of researchers into U.S.-mobility versus intra-EU mobility. As mentioned in the data section, we only consider researchers with outward mobility experience, i.e. who move to the United States or within Europe after obtaining their PhD degree in Europe, either in their birth country or in another European country.

4.1 Descriptive statistics

Table 1 displays the means of four dummy variables for negative, neutral, positive and strongly positive effects for the 8 different effects for the total mobile sample and by destination of mobility[4]. On the whole, the majority of mobile researchers perceive positive to very positive effects from mobility. A small share of researchers report negative effects: 14% feel their future job opportunities have decreased. Fewer than 10% of researchers report any negative effects on the remaining items. The item that receives the highest score on positive and very positive effects is peer recognition.

Table 1: Probability of negative-neutral-positive-strongly positive effects by destination of mobility

		intra-EU %	US %	Total
publication output	Decreased	7.58	3.63	5.27
	Neutral	25.67	22.84	24.01
	Increased	48.41	48.96**	48.73
	strongly increased	18.34	24.57**	21.99
Peer recognition	Decreased	2.93	1.38	2.02
	Neutral	13.66	11.02	12.11
	Increased	62.20	53.01*	56.81
	strongly increased	21.22	34.60***	29.06
access to infrastructure	Decreased	4.13	1.17	2.39
	Neutral	24.79	17.12	20.30
	Increased	53.72	56.03***	55.07
	strongly increased	17.36	25.68***	22.23
access to professional network	Decreased	3.18	0.69	1.72
	Neutral	16.38	11.57	13.56
	Increased	50.86	49.22***	49.90
	strongly increased	29.58	38.51***	34.82
professional experience	Decreased	1.95	0.69	1.21
	Neutral	5.11	3.09	3.93
	Increased	54.26	44.33**	48.44
	strongly increased	38.69	51.89***	46.42
job opportunities	Decreased	13.14	14.67	14.04
	Neutral	35.05	25.58	29.46
	Increased	38.40	39.71**	39.18

[4] Given that there are so few observations with strongly negative and negative effects, we combine these two categories for the remainder of the analysis.

	strongly increased	13.40	20.04***	17.32
patent output	Decreased	8.76	7.69	8.17
	Neutral	74.45	66.27	69.93
	Increased	14.60	17.75*	16.34
	strongly increased	2.19	8.28**	5.56
ability to work in industry	Decreased	8.79	3.86	5.90
	Neutral	55.49	49.03	51.70
	Increased	30.77	35.91**	33.79
	strongly increased	4.95	11.2**	8.62

Note: *** p<0.01, ** p<0.05, * p<0.1 for t-tests. For 'increased', the t-tests include the strongly increased category as well.

Mobility to the United States leads to positive effects more frequently than intra-EU mobility. A series of t-tests show that researchers mobile to the United States report positive effects more frequently than researchers mobile within Europe. The effects of mobility to the U.S. are also significantly more likely to be strongly positive: for some effects, like patent output and peer recognition, the difference between intra-EU mobile and U.S. mobile researchers is only significant at 10% for positive effects, but significant at the 1%-level for strongly positive effects. At first sight, these descriptive statistics suggest that mobility to the United States has larger perceived benefits for researchers.

4.2 Econometric analysis

In this section, we verify whether the results suggested by the descriptive findings still hold up in a multivariate analysis. Does mobility to the United States still have stronger effects compared to intra-EU mobility once other factors are controlled for?

To examine this, we estimate a multinomial logit model with four possible outcomes: negative effects, neutral effects (the base outcome), positive effects and strongly positive effects. We include a series of control variables. These include gender, age, cohort, whether the researcher has currently returned home or is still mobile, the field in which researchers obtained their highest degree, the different European regions of birth, and the relative impact of the degree country's scientific publications. The complete regression tables can be found in Appendix 2 (tables A.1 & A.2). Table 2 contains the relative risk ratios for mobility to the U.S. The relative risk ratios are the exponentiated coefficients, and are interpreted as the

factor change in the relative probability of an outcome relative to the base outcome for a one-unit change in the associated explanatory variable.

For all effects, mobility to the U.S. is clearly associated with a higher probability of strongly positive effects, and these effects are quite large: for example, U.S.-mobile researchers are 60% more likely to report strong increases in publication output, and more than two times more likely to indicate a strong increase in peer recognition.

Table 2: Multinomial logit for negative, positive and strongly positive effects relative to neutral effects - relative risk ratios for mobility to the US compared to intra-EU

	Decreased	increased	strongly increased
publication output	0.441**	1.170	1.591**
Peer recognition	0.505	1.126	2.115***
access to infrastructure	0.415	1.723***	2.555***
international network	0.284*	1.537**	2.024***
professional experience	0.729	1.479	2.565***
future job opportunities	1.455	1.573***	2.079***
patent output	0.982	1.550	5.436**
ability to work in industry	0.388*	1.513*	2.862**

For publication output effects, mobility to the U.S. works at the extremes: it decreases the probability of a negative effect, and increases the likelihood of a strongly positive effect, but not of a positive effect relative to a neutral one. For the ability to work in industry and access to an international network of professionals, mobility to the U.S. is associated with a lower probability of negative effects and higher probabilities of positive and strongly positive effects. For peer recognition, mobility to the US yields significantly higher probability of strongly increased effects. Also for professional experience and patent output, mobility to the U.S. is only significantly related to a higher probability of strongly positive effects. For future job opportunities and access to infrastructure mobility to the U.S. is associated with a higher probability of reporting positive effects, be they positive or strongly positive, compared to neutral effects.

The regression results indicate that mobility to the United States is associated with stronger positive effects of mobility. The question remains why. Do the United States provide a considerably better research environment, that helps researchers realize more of their potential than in Europe? Or do the United States manage to attract a different breed of

European mobile researchers, who report better effects of mobility because of their inherent characteristics? The next section addresses these questions.

4.3 Propensity score matching

In this section, we check whether mobility to North America indeed has larger positive effects compared to mobility within Europe, or whether the positive effects we observe are due to selection. We consider 'mobility to the U.S.' as a treatment (and, consequently, researchers mobile within Europe as the untreated control group), and use a matching model to match each 'treated' researcher to an 'untreated' one that is as similar as possible in his or her observed characteristics. We use propensity score matching, matching U.S.-mobile researchers to EU-mobile researchers with a similar propensity to move to North America. We then calculate the differences in mobility effects between the matched treated and untreated groups, and check whether the differences remain significant.

To calculate the propensity score, we run a logit model for the probability of being mobile to the U.S compared to being mobile within Europe. This model includes age, gender, cohort, scientific field, the region of birth, a dummy for whether the researcher had returned home at the time of the survey or was still mobile, a dummy for current job in industry to control for differences in opportunities for mobility in industry and academia and the relative impact of the degree country's publications. Additionally, the model also includes a dummy for researchers who obtained their PhD in Europe but outside the birth country to control for differences in mobility destinations due to earlier mobility experience. Three sets of motivations for mobility are included: career motivations, personal motivations and financial motivations. We also control for external influencing factors for mobility: regulatory factors, personal factors, concerns about funding, potential loss of contacts and language[5]. The results of the logit model are reported in appendix table A.3.

[5] The survey asked researchers to score 7 motivations for mobility on a scale from 1 to 5, ranging from not important at all to extremely important. These motivations were regrouped and averaged into three motivation factors, including career motivations, personal motivations and financial motivations. Similarly, the survey asked respondents to score 8 external influencing factors for mobility on a scale from 1 to 5, which were regrouped and averaged into regulatory factors, personal factors, concerns about funding, potential loss of contacts and language. See Van Bouwel, Lykogianni & Veugelers (2012) for more on the analysis of the determinants of mobility.

The propensity score for each researcher is calculated as the predicted probability for U.S. mobility. We use kernel matching: each U.S.-mobile researcher is matched to all EU-mobile researchers, but those EU-mobile researchers with the most similar propensity score receive a larger weight, whereas those with a strongly differing propensity score get a smaller weight. This approach is more efficient than nearest-neighbor matching because it uses all available information[6]. It does, however, increase the standard errors because researchers who are very different from the treated group still receive a positive weight. The treated and untreated groups should be very similar in their observed characteristics after matching. Table 3 compares researchers' characteristics prior to and after matching.

Table 3: Comparison of observable characteristics prior to and after matching (kernel matching)

	Unmatched		Matched	
Variable	treated	Untreated	treated	Untreated
Male	0.73	0.75	0.73	0.74
Age	45.16	43.56**	45.13	45.04
cohort 10-19	0.29	0.35*	0.29	0.31
cohort 20-29	0.15	0.14	0.15	0.15
cohort 30-49	0.15	0.07***	0.15	0.14
Currently returned	0.60	0.60	0.60	0.56
Industry	0.03	0.03	0.03	0.04
EU degree	0.11	0.18***	0.11	0.12
career motivations	3.99	3.69***	3.99	3.99
personal motivations	2.52	2.43	2.52	2.57
financial motivations	2.69	2.69	2.69	2.72
regulatory influencing factors	1.77	1.79	1.77	1.84
Funding	2.96	2.84	2.96	2.91
loss of contacts	2.10	2.10	2.10	2.14
personal influencing factors	2.17	2.00**	2.17	2.25
Language	2.92	2.46***	2.92	2.95
exact sciences	0.59	0.58	0.59	0.59
life sciences	0.12	0.08**	0.12	0.12
social sciences	0.22	0.26	0.22	0.22
Mediterranean countries	0.35	0.41	0.35	0.35
Anglo-Saxon countries	0.11	0.04***	0.11	0.10
Scandinavia	0.09	0.10	0.09	0.10
Central and Eastern Europe	0.09	0.15***	0.09	0.09
relative impact of degree country publications	0.94	0.91***	0.94	0.94

[6] As a robustness check we also do nearest-neighbor matching. Although the outcomes are very similar, nearest-neighbor matching does not result in a 'perfect match', in the sense that some significant differences between the treated and untreated groups remain. We therefore only report Kernel matching results.

Prior to matching, there are several significant differences between U.S.-mobile and EU-mobile researchers, as discussed also in Van Bouwel, Lykogianni and Veugelers (2012). U.S.-mobile researchers are significantly older and from earlier cohorts. They are more likely to be working in the life sciences and to come from an Anglo-Saxon country. European researchers who obtained their PhD in another European countries, are more likely to choose a European destination rather than the US for their post-doc mobility. Also researchers from Mediterranean or Central and Eastern European countries are more likely to be intra-EU mobile rather than to the US.

A number of factors hint at U.S.-mobile researchers having higher productivity profiles. They are significantly more career motivated. U.S.-mobile researchers also obtained their PhD in countries whose publications have a relatively higher average impact compared to the degree countries of EU-mobile researchers. The kernel matching, however, manages to eliminate all significant differences between the treated group and the control group: no significant differences in observable factors are left after matching.

The matching procedure does not guarantee that heterogeneity between the treated and untreated groups is eliminated, as unobserved heterogeneity which is correlated with the mobility effects might remain unaccounted for. One important characteristic that remains unobserved is the researcher's ability. If researchers with greater talent for research are more likely to move to the United States, then any positive effect from U.S. mobility could be attributable to this selection that we cannot control for directly. We capture researchers' ability only indirectly with such variables as the quality of the degree country or career motivations (assuming that more talented researchers are more likely to be mobile with the goals of furthering their research agenda). However, ideally we would want to control for ability directly to be able to match researchers of similar ability. Unfortunately, the survey does not provide a direct measure of ability.

A source of heterogeneity which would disturb the interpretation of our results is selective subjectivity, i.e. if U.S.-mobile researchers are significantly more 'optimistic' types, consistently over-estimating the positive effects of their mobility compared to intra-EU

mobile researchers, who might be more 'cautious' types. We have no way to correct for this bias[7].

Table 4 compares the mean effects of U.S.-mobile and EU-mobile researchers before and after matching. Before matching, U.S.-mobile researchers report significantly higher effects across the board, as suggested by the analysis in the previous section. After matching, however, the U.S.-mobile researchers still have somewhat higher mobility effects compared to EU mobile researchers, but most differences are no longer significant. Researchers mobile to the United States still perceive more positive effects in their access to infrastructure and professional experience as a researcher[8]. However, these advancements do not appear to translate into higher scientific output or increased peer recognition, the main 'output' effects. This suggests that most positive differences in effects observed prior to matching are due to the selection of researchers with particular characteristics to the U.S. and there is no 'U.S.-effect' that makes mobility to the U.S. pay off more than mobility within the EU, but rather, the U.S. manages to attract the type of researchers who are more likely to experience positive effects from mobility.

Table 4: Propensity score matching (kernel): differences in effects

Effect	NA mobile (treated)	EU mobile (untreated)	Difference	t-stat
prior to matching				
publication output	3.94***	3.76	0.18	3.39
Peer recognition	4.21***	4.01	0.19	4.37
access to infrastructure	4.06***	3.83	0.23	4.58
international network	4.25***	4.06	0.19	4.14
professional experience	4.47***	4.29	0.18	4.42
job opportunities	3.61*	3.49	0.12	1.87
patent output	3.24**	3.07	0.17	2.06
work in industry	3.52***	3.30	0.23	3.13
after matching				
publication output	3.94	3.84	0.11	1.64
Peer recognition	4.21	4.15	0.05	0.95
access to infrastructure	4.06***	3.90	0.16	2.61
international network	4.25	4.19	0.06	1.07

[7] Sauermann & Rauch (2012) suggest the use of a "neutral question" as reference to correct for this bias. Unfortunately the MORE survey did not contain such a question.
[8] Results on split samples by scientific disciplines(results not reported) show that the effect on access to infrastructure and professional experience are mainly attributable to researchers in the exact sciences.

professional experience	4.47**	4.37	0.11	2.09
job opportunities	3.61	3.57	0.08	0.56
patent output	3.24	3.13	0.12	1.17
work in industry	3.53	3.42	0.11	1.16

The multinomial logit model in the previous section indicated that U.S. mobility is consistently associated with a higher likelihood of strongly positive effects. Instead of using the 'average effect' on a scale from 1 to 5 as the outcome variable, we use a dummy variable that is 1 if the researcher reports a strongly positive effect. Table 5 displays the results for this kernel matching model for strongly positive effects.

Table 5: Propensity score matching for strongly positive effects

Effect	NA mobile (treated)	EU mobile (untreated)	Difference	t-stat
prior to matching				
publication output	0.25**	0.18	0.06	2.33
Peer recognition	0.35***	0.21	0.13	4.61
access to infrastructure	0.26***	0.17	0.08	2.93
international network	0.38***	0.30	0.09	2.91
professional experience	0.52***	0.39	0.13	4.14
job opportunities	0.20***	0.13	0.07	2.66
patent output	0.08**	0.02	0.06	2.33
work in industry	0.11**	0.05	0.06	2.31
after matching				
publication output	0.25	0.23	0.02	0.65
Peer recognition	0.35	0.30	0.04	1.35
access to infrastructure	0.26	0.21	0.05	1.53
international network	0.38	0.38	0.00	0.14
professional experience	0.52*	0.45	0.07	1.81
job opportunities	0.20	0.17	0.03	0.93
patent output	0.08**	0.02	0.06	2.17
work in industry	0.11	0.06	0.05	1.52

Prior to matching, there are strongly significant differences in the probability of reporting strongly positive effects between U.S.-mobile and EU-mobile researchers. After matching, some significant differences remain. Researchers mobile to the U.S. are significantly more likely to report strong increases in their patent output. The share of researchers reporting these strong effects is small, however: 8% of U.S.-mobile researchers report strong increases in patent output, compared to 1% of EU-mobile researchers. A split sample analysis (not

reported) shows that these effects on patent output are driven by researchers in the exact sciences. Also significantly higher, though only at the 10% level, is a strong increase in professional experience. There is no significant difference in the share of researchers who report strong increases in their access to infrastructure or peer recognition.

In conclusion, on average most of the stronger 'U.S. effects' for mobile European researchers are accounted for by selection.

5. CONCLUSION

Policy makers and scholars often assume that international mobility of researchers has positive effects. However, to date the evidence of the effects of researcher mobility on researchers themselves remains limited. Using data from the MORE survey on European-born and European-educated researchers who are internationally mobile within Europe or to the United States, we find that researchers report positive effects from international mobility on a range of facets, including scientific productivity, peer recognition, career development and future job opportunities.

Researchers mobile to the United States consistently report stronger positive effects than their peers who are mobile within the EU. This apparent 'U.S. premium', however, is almost entirely due to selection. Amongst other differences, researchers mobile to the U.S. are more strongly career motivated. After accounting for this selection with a propensity score matching model, there are hardly any differences in the effects reported by U.S.-mobile and EU-mobile researchers, with the exception of access to infrastructure and professional experience, a result mainly driven by researchers in the exact sciences.

These results suggests that European policy makers should be careful that their support for intra-EU mobility does not divert attention away from U.S. mobility, as this mobility seems to have a higher effectiveness. More importantly, however, if Europe wants to promote an equally effective intra-EU mobility, it needs to address the selection issue, and create the conditions that will induce the more career motivated researchers who are most likely to benefit from international mobility to choose the EU for their mobility destination.

This research suffers from a few drawbacks inherent in the MORE survey, most notably because the effect measurements are based on self-reported survey data. To avoid the possible biases inherent to survey data in the measurement of mobility effects, one could use quantitative data such as publications, citations, and international collaborations. It is not straightforward to estimate the counterfactual of how publication output or future job opportunities would have evolved had the researcher not become mobile. In any case, selection remains a major issue which is not easily controlled for, especially in the absence of good measures of researcher ability. Natural experiments or instruments which provide an exogenous source of variation in possibilities for international mobility are also not readily available.

Nevertheless, it is important to continue expanding and refining the data collection on researcher mobility, and particularly on the effects of mobility, to support a more evidence based design of incentive policies to stimulate mobility or to attract researchers from abroad.

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APPENDIX 1: THE MORE SURVEY AND OUR SAMPLE

The analysis is based on survey data from the extra-EU MORE survey. The extra-EU MORE survey is part of a group of surveys carried out in the context of a study on mobility patterns and career paths of EU researchers ('MORE')[9]. In the MORE survey, mobility is defined as a minimum three-month stay in a country different from the country where the highest degree was obtained. The target group are researchers who obtained their highest degree in the EU and who work in the U.S. for a minimum of three months. There are three additional target groups: researchers who obtain their highest degree in the U.S. and who work in the EU for a minimum of three months, researchers who have been mobile but who do not belong in the previous two groups, and researchers who have not been internationally mobile.

The main sampling method of the survey was a web-based search[10]. The sampling method allowed to construct a relatively large group of respondents, but the convenience sampling method also has drawbacks. The major drawback is a lack of information on the representativeness of the sample relative to the underlying population. To date there are no data sources that identify this population. The survey sample cannot be corrected for possible biases that distort its representativeness. The findings drawn from these data therefore cannot be generalized to the whole population, and are valid only for this particular sample. Despite these caveats, given the scarcity of data on EU researchers and particularly on mobility, this sample provides an interesting source of information.

The survey was initially sent to 93,183 e-mail addresses. Out of these, 22,206 people viewed the email and 5,572 responded (6% of the total invited and 25% of those who viewed the e-mail), of which 4,571 respondents fully completed the questionnaire. An additional 1,393 fully completed surveys were received from non-panel individuals, adding up to a total of 5,964 fully completed questionnaires. After cleaning out responses, a total of 5,544

[9] This study was carried out by IDEA Consult in consortium with NIFU Step, WIFO, Logotech and the University of Manchester for the European Commission in 2009-2010.

[10] The search identified html-pages or pdf files which match a few keywords that identify an academic CV and likely mobility between the US and the EU. The resulting list of e-mail addresses was the primary direct sampling source. Indirect sampling methods were also used, including publishing the survey on LinkedIn and forwarding it to the Euraxess community, the EU Centres of Excellence in the U.S., and the coordinators of the ATLANTIS Programme on EU-U.S. Cooperation in Higher Education and Vocational Training.

responses remained. This sample was used for the MORE report for the European Commission (MORE, 2010).

We have no data available to assess the extent to which this sample is biased towards EU-U.S. mobility. As a small check, we compared the researchers in our sample who are currently residing in Belgium to the Belgian sample of the Careers of Doctorate Holders survey (CDH) carried out in several OECD countries in 2006 in cooperation with the OECD, Eurostat and UNESCO Institute of Statistics[11]. The CDH sample only includes PhD holders currently working in Belgium and does not take into account researchers who moved abroad permanently or who have not yet returned. This biases the mobility rates picked up in CDH downwards. The comparison reveals that our sample picks up four times as much 'career mobility' (i.e. mobility after the highest degree is obtained) as the CDH sample, and this mobility is more likely to be geared towards North America: 52% of career mobility goes toward the U.S. in our sample, versus 12% in the CDH sample. This indicates that the MORE sample is strongly biased towards EU-U.S. mobility. The true population mobility rates are likely to lie somewhere between the MORE estimate and the CDH estimate. As we have no good information to correct for the bias, we hope that the non-representativeness of our sample affects the alternative-specific constants in our econometric analysis, but not necessarily the estimates for the determinants of mobility destination outcomes (Train, 2002). Nevertheless, results should be interpreted with caution, especially the descriptive statistics.

The survey itself consists of two parts: the first addresses all mobility groups and asks about researchers' personal and family situation, education and training, current employment as a researcher and experience of mobility. The second part asks respondents about their views on mobility, including personal motivations for mobility, external influencing factors for the decision to become mobile and the effects they experienced from mobility. The second part differs by target group. Although the questions to the immobile group were designed to be 'mirror questions' to those for the mobile group, a different wording was used, which may have caused a different interpretation by mobile and non-mobile respondents[12]. This implies

[11] We are gratefully to the Belgian Federal Science Policy Office to allow us access to the data.

[12] For example, one of the questions in the EU-U.S. mobile group is 'To what extent were the following aspects important as factors motivating you to become mobile to the U.S.?', whereas the mirror questions for the non-mobile group is 'To what extent were the following aspects important as factors dissuading you to become mobile?'. Aspects such as family considerations may be given little weight by the first group if they became

we cannot use the data to compare mobile researchers to non-mobile researchers. However, we can address the question whether the effects of mobility differ among researchers mobile to different destinations. Moreover, in the survey only the respondents who had experienced international mobility were asked to indicate whether a number of outputs had increased or decreased as a consequence of that mobility.

mobile *despite* family considerations, even if family considerations received a lot of weight in the overall mobility decision, and vice versa for the non-mobile group.

APPENDIX 2: RESULTS TABLES

Table A.1: Multinomial logit model for negative, positive and strongly positive effects relative to neutral effects (1-4) – relative risk ratios

VARIABLES	Publication output			Peer recognition			Access to infrastructure			International network		
	decreased	increased	strongly increased	decreased	increased	strongly increased	decreased	increased	strongly increased	decreased	increased	strongly increased
mobility to NA	0.441**	1.170	1.591**	0.505	1.126	2.115***	0.415	1.723***	2.555***	0.284*	1.537**	2.024***
	(0.145)	(0.196)	(0.321)	(0.269)	(0.235)	(0.491)	(0.224)	(0.319)	(0.576)	(0.185)	(0.315)	(0.436)
1 if male	0.716	0.773	1.291	0.910	1.566**	1.571*	1.113	1.014	0.787	3.446	1.052	0.964
	(0.261)	(0.148)	(0.310)	(0.497)	(0.357)	(0.393)	(0.647)	(0.219)	(0.197)	(2.790)	(0.250)	(0.237)
Age in years	0.954	1.002	1.002	0.966	0.971	0.962	0.903	0.973	0.982	0.987	0.986	0.977
	(0.0382)	(0.0183)	(0.0214)	(0.0558)	(0.0215)	(0.0236)	(0.0565)	(0.0190)	(0.0228)	(0.0596)	(0.0216)	(0.0224)
cohort 10-19	1.144	1.301	1.670*	1.936	1.530	2.400**	2.129	1.260	0.891	0.459	1.336	1.340
	(0.592)	(0.329)	(0.504)	(1.478)	(0.481)	(0.825)	(1.713)	(0.349)	(0.295)	(0.403)	(0.414)	(0.434)
cohort 20-29	1.726	0.802	1.608	0.591	1.789	2.357	3.463	1.184	1.017	1.14e-06	1.363	1.564
	(1.531)	(0.331)	(0.770)	(0.913)	(0.892)	(1.301)	(4.860)	(0.516)	(0.532)	(0.000562)	(0.687)	(0.824)
cohort 30-49	3.194	1.396	1.763	2.571	2.820	4.070*	19.83	1.243	0.622	0.907	0.983	1.016
	(3.959)	(0.797)	(1.182)	(4.817)	(1.964)	(3.137)	(36.18)	(0.743)	(0.456)	(1.638)	(0.661)	(0.721)
Currently returned	0.568	1.529**	0.899	0.155***	0.919	0.649*	0.474	1.076	0.526***	0.319*	2.027***	1.522*
	(0.196)	(0.270)	(0.186)	(0.0980)	(0.209)	(0.159)	(0.242)	(0.214)	(0.123)	(0.209)	(0.434)	(0.340)
Exact Sciences	1.768	0.794	0.932	1.203	0.934	0.576	0.494	0.747	0.800	341,456	1.050	1.199
	(1.401)	(0.254)	(0.362)	(1.392)	(0.380)	(0.245)	(0.569)	(0.293)	(0.372)	(2.297e+08)	(0.384)	(0.471)
Life Sciences	3.752	0.809	1.092	1.450	0.880	0.627	0.956	0.649	0.896	349,483	1.155	1.535
	(3.257)	(0.321)	(0.514)	(1.949)	(0.433)	(0.324)	(1.253)	(0.299)	(0.484)	(2.351e+08)	(0.542)	(0.759)
Social Sciences	0.973	0.853	1.166	1.629	1.247	0.698	1.615	0.603	0.672	635,915	1.476	1.971
	(0.829)	(0.290)	(0.482)	(1.974)	(0.540)	(0.320)	(1.834)	(0.249)	(0.331)	(4.277e+08)	(0.600)	(0.854)
Mediterranean	0.779	1.326	1.343	0.456	0.967	1.067	1.767	1.491	1.304	1.069	1.158	1.015
	(0.347)	(0.296)	(0.353)	(0.315)	(0.279)	(0.331)	(1.205)	(0.375)	(0.387)	(0.806)	(0.316)	(0.289)
Anglosaxon Europe	1.720	1.300	1.075	2.447	0.788	0.941	1.431	1.102	0.890	2.857	0.712	0.949
	(0.948)	(0.431)	(0.411)	(1.923)	(0.338)	(0.421)	(1.323)	(0.387)	(0.380)	(2.825)	(0.266)	(0.359)
Scandinavia	1.354	0.525**	0.435**	7.29e-07	0.762	0.571	3.463*	0.941	1.033	2.537	1.421	0.901
	(0.644)	(0.147)	(0.162)	(0.000563)	(0.260)	(0.225)	(2.389)	(0.298)	(0.405)	(2.401)	(0.541)	(0.373)
Central and Eastern Europe	0.542	1.346	1.534	0.190	2.433	1.642	3.23e-06	1.809	2.357*	1.516	1.361	0.915
	(0.478)	(0.532)	(0.698)	(0.299)	(1.378)	(1.008)	(0.00226)	(0.833)	(1.219)	(1.650)	(0.640)	(0.457)
relative impact per degree country publication	3.205	0.531	0.446	0.0602	1.490	1.686	10.75	0.828	0.676	0.284	1.502	0.726
	(4.068)	(0.341)	(0.334)	(0.138)	(1.289)	(1.584)	(24.39)	(0.612)	(0.570)	(0.519)	(1.164)	(0.594)
Constant	0.610	2.890	0.794	28.47	6.116	4.354	0.694	7.791*	3.906	1.73e-06	1.675	3.431
	(1.289)	(3.014)	(0.970)	(95.38)	(8.301)	(6.403)	(2.464)	(9.380)	(5.444)	(0.00116)	(2.095)	(4.497)
Observations	987	987	987	991	991	991	877	877	877	988	988	988

Table A.2: Multinomial logit model for negative, positive and strongly positive effects relative to neutral effects (5-8) – relative risk ratios

VARIABLES	Professional experience			Future job opportunities			Patent output			Ability to work in industry		
	decreased	increased	strongly increased	decreased	increased	strongly increased	decreased	increased	strongly increased	decreased	increased	strongly increased
mobility to NA	0.729	1.479	2.565***	1.455	1.573***	2.079***	0.982	1.550	5.436**	0.388*	1.513*	2.862**
	(0.523)	(0.516)	(0.900)	(0.341)	(0.263)	(0.449)	(0.442)	(0.529)	(3.905)	(0.188)	(0.345)	(1.240)
1 if male	1.508	1.753	1.498	0.854	1.498**	1.408	1.577	0.597	8.149*	0.948	1.094	0.739
	(1.215)	(0.650)	(0.557)	(0.221)	(0.289)	(0.339)	(0.890)	(0.212)	(9.190)	(0.494)	(0.298)	(0.328)
Age in years	1.081	1.040	1.010	1.016	0.970*	0.963	0.993	1.019	0.864	1.025	0.997	0.980
	(0.0816)	(0.0424)	(0.0414)	(0.0258)	(0.0171)	(0.0227)	(0.0571)	(0.0396)	(0.0824)	(0.0455)	(0.0233)	(0.0422)
cohort 10-19	0.825	1.291	1.353	1.003	1.094	1.002	2.238	1.394	13.05**	1.377	1.118	2.264
	(0.902)	(0.714)	(0.753)	(0.350)	(0.272)	(0.314)	(1.642)	(0.727)	(15.22)	(0.890)	(0.363)	(1.344)
cohort 20-29	0.567	0.475	0.979	1.137	1.089	0.799	2.529	0.826	11.57	0.606	1.060	2.369
	(0.954)	(0.425)	(0.879)	(0.641)	(0.437)	(0.428)	(2.936)	(0.703)	(23.79)	(0.658)	(0.573)	(2.374)
cohort 30-49	0.504	0.481	0.714	0.341	0.740	0.676	1.353	0.682	200.9*	0.878	0.769	7.195
	(1.155)	(0.610)	(0.910)	(0.277)	(0.405)	(0.499)	(2.492)	(0.856)	(619.0)	(1.257)	(0.589)	(9.577)
Currently returned	0.164**	1.216	1.217	0.176***	1.186	1.198	0.286**	0.670	0.221**	0.160***	0.506***	0.155***
	(0.131)	(0.437)	(0.439)	(0.0455)	(0.218)	(0.270)	(0.139)	(0.251)	(0.141)	(0.0857)	(0.128)	(0.0674)
Exact Sciences	729,160	1.180	1.537	1.465	1.091	2.443*	0.0653***	0.167**	2.343e+06	0.0525***	3.015	0.388
	(6.154e+08)	(0.702)	(0.927)	(0.646)	(0.338)	(1.200)	(0.0587)	(0.123)	(7.697e+09)	(0.0472)	(3.322)	(0.379)
Life Sciences	1.917e+06	1.109	1.905	0.888	0.461**	1.886	0.135**	0.224*	517,610	0.0771**	3.330	0.561
	(1.618e+09)	(0.897)	(1.546)	(0.469)	(0.179)	(1.032)	(0.127)	(0.179)	(1.700e+09)	(0.0786)	(3.754)	(0.573)
Social Sciences	1.875e+06	1.188	1.440	0.919	1.124	1.942	0.0608**	0.359	1.252	0.161*	7.600*	0.807
	(1.582e+09)	(0.759)	(0.932)	(0.444)	(0.369)	(1.000)	(0.0799)	(0.298)	(4,597)	(0.159)	(8.588)	(0.884)
Mediterranean	2.543	1.326	1.587	0.999	1.185	0.844	0.796	1.410	0.612	0.717	0.715	0.935
	(2.179)	(0.589)	(0.707)	(0.297)	(0.272)	(0.235)	(0.498)	(0.660)	(0.471)	(0.465)	(0.224)	(0.476)
Anglosaxon Europe	1.24e-06	1.123	1.065	1.394	1.607	1.369	1.123	0.774	0.441	2.684	0.595	0.324
	(0.00101)	(0.695)	(0.662)	(0.586)	(0.582)	(0.575)	(1.026)	(0.664)	(0.420)	(2.070)	(0.273)	(0.244)
Scandinavia	3.010	2.718	2.509	0.358*	1.055	0.540	1.605	0.299	1.59e-07	2.706	0.945	1.177
	(4.155)	(2.105)	(1.959)	(0.189)	(0.302)	(0.206)	(1.444)	(0.332)	(0.000306)	(2.022)	(0.393)	(0.780)
Central and Eastern Europe	0.789	0.886	1.692	0.571	1.576	0.565	0.760	1.980	0.266	0.933	0.763	0.474
	(1.315)	(0.696)	(1.320)	(0.318)	(0.621)	(0.303)	(0.745)	(1.384)	(0.348)	(0.891)	(0.376)	(0.416)
relative impact per degree country publication	0.0611	0.182	0.197	2.349	2.732	4.780*	0.479	1.384	0.778	0.232	0.421	0.471
	(0.160)	(0.228)	(0.247)	(2.106)	(1.786)	(3.999)	(0.768)	(1.543)	(1.611)	(0.390)	(0.343)	(0.680)
Constant	2.00e-07	4.637	6.878	0.204	0.885	0.192	3.691	0.423	8.07e-07	7.073	0.670	1.830
	(0.000169)	(9.732)	(14.47)	(0.290)	(0.916)	(0.263)	(11.00)	(0.926)	(0.00265)	(19.58)	(1.181)	(4.691)
Observations	993	993	993	947	947	947	306	306	306	441	441	441

seEform in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table A.3: Logit model for mobility to the U.S. versus intra-EU

VARIABLES	Mobility to U.S. vs EU
1 if male	-0.210
	(0.165)
Age in years	0.00359
	(0.0155)
cohort 10-19	-0.0623
	(0.214)
cohort 20-29	-0.0525
	(0.354)
cohort 30-49	0.714
	(0.489)
return to degree country	-0.118
	(0.169)
Industry	0.0759
	(0.400)
intra-EU degree mobility	-0.428*
	(0.233)
career motivations	0.587***
	(0.100)
personal motivations	-0.0135
	(0.0851)
money motivations	-0.0191
	(0.0661)
regulatory influencing factors	-0.177*
	(0.100)
research funding	-0.123**
	(0.0596)
loss of contacts	-0.0886
	(0.0726)
personal influencing factors	0.191**
	(0.0899)
Language	0.364***
	(0.0659)
Exact Sciences	0.118
	(0.268)
Life Sciences	0.381
	(0.336)
Social Sciences	-0.171
	(0.284)
Mediterranean	-0.405**
	(0.198)
Anglosaxon Europe	0.713**
	(0.321)
Scandinavia	-0.263
	(0.256)
Central and Eastern Europe	-0.640*
	(0.349)
relative impact per degree country publication	0.405
	(0.581)
Constant	-2.527**
	(1.009)
Observations	998

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

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